

800827

ENVIRONMENTAL LEVELS OF RADIOACTIVITY  
FOR THE OAK RIDGE AREA

(Report for Period July - December, 1966)

Compiled by the

Health Physics and Safety Section

Health Physics Division

OAK RIDGE NATIONAL LABORATORY

APPROVAL FOR RELEASE

Document: # Unnumbered (17 pp) ; Date ND ;

Title/Subject ENVIRONMENTAL LEVELS OF RADIOACTIVITY  
FOR THE OAK RIDGE AREA (Report for Period July-  
December, 1966)

Approval for unrestricted release of this document is authorized by the Oak Ridge K-25 Site Classification and Information Control Office, Martin Marietta Energy Systems, Inc., PO Box 2003, Oak Ridge, TN, 37831-7307.

Arvin Smith 1/29/93  
K-25 Classification & Information Control Officer Date

#499  
b6  
b7C

## Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are concentrated by evaporation and disposed of in deep wells. Low level liquid wastes are discharged, after preliminary treatment, to surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of scrubbers and filters.

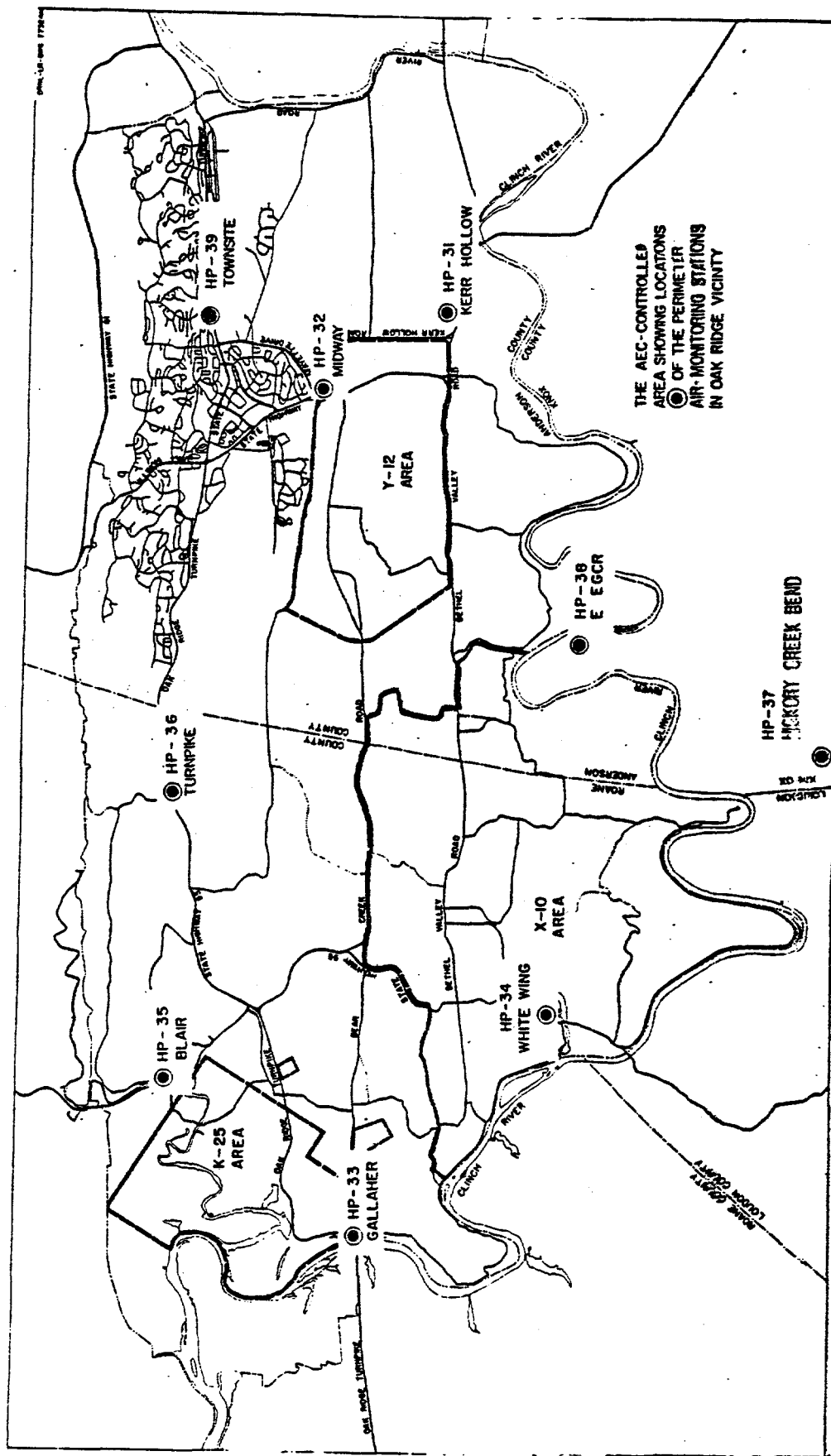
This report presents data on the environmental levels of radioactivity for the Oak Ridge area and compares the data with established maximum permissible concentrations.

## Air Monitoring

Atmospheric contamination by radioactive materials occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of nine stations which encircle the plant area (Fig. 1) and provide data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of eight stations encircling the Oak Ridge area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Airborne radioactive iodine is monitored in the immediate environment of the plant areas by passing air through a cartridge containing activated charcoal. Data collected are accumulated and tabulated in average  $\mu\text{c/cc}$  of air sampled.

## Milk Monitoring

Raw milk is monitored for  $^{131}\text{I}$  and  $^{90}\text{Sr}$  by the collection and analysis of samples from twelve sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations located on the fringe of the Oak Ridge area. Four stations, located more remotely with respect to Oak Ridge Operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is two-fold: first, samples collected in the immediate vicinity of the Oak

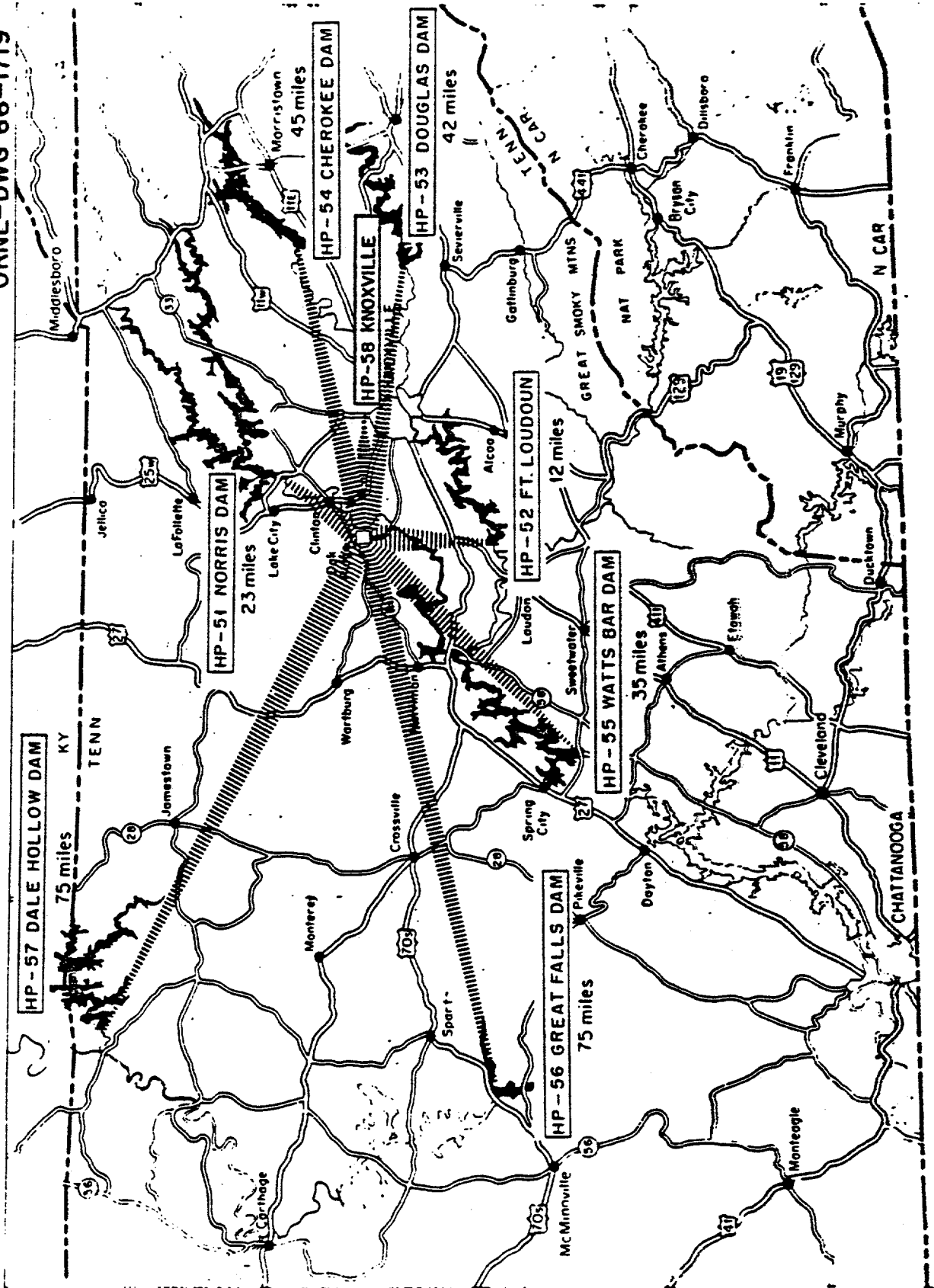


THE AEC-CONTROLLED  
AREA SHOWING LOCATIONS  
OF THE PERIMETER  
AIR-MONITORING STATIONS  
IN OAK RIDGE VICINITY

STATION SITES FOR PERIMETER AIR MONITORING SYSTEM

Figure 1

ORNL-DWG 66-1719



Ridge area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge Operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

### Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for populations in the neighborhood of a controlled area as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 3 and 4. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only, since cooling time and hold-up time in the waste effluent system are such that short-lived radionuclides are normally not present. The concentrations of those isotopes present in significant amounts are determined by analysis. A weighted average maximum permissible concentration for water,  $(MPC)_w$ , for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as specified by AEC Manual, Chapter 0524.<sup>1</sup> The average concentrations of gross beta activity in the Clinch River are compared to the calculated  $(MPC)_w$  values.

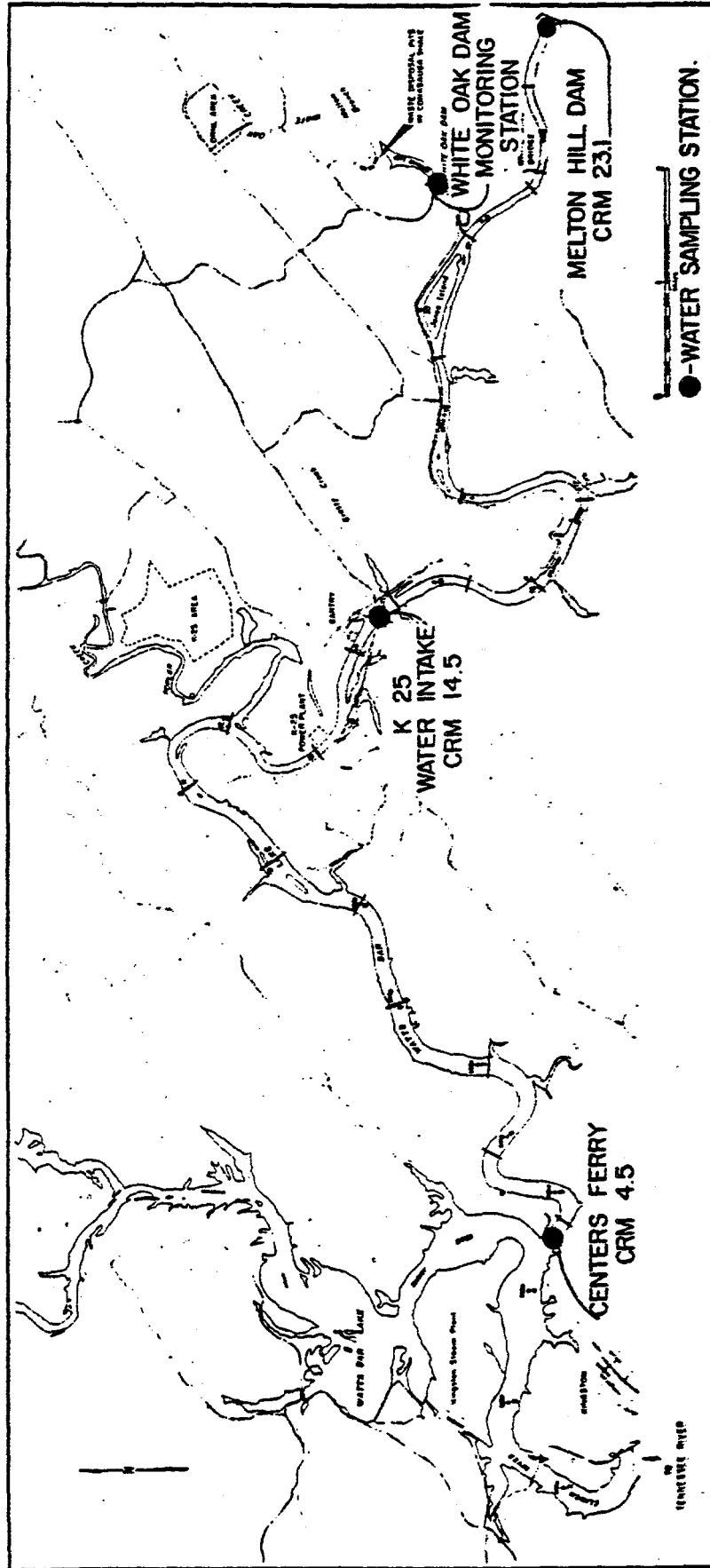
The concentration of uranium is compared with the specific  $(MPC)_w$  value for uranium.

### Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

<sup>1</sup>AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

ORNL-DWG. 66-2216R



WATER SAMPLING LOCATIONS

Figure 3

ORNL-DWG. 66-1810

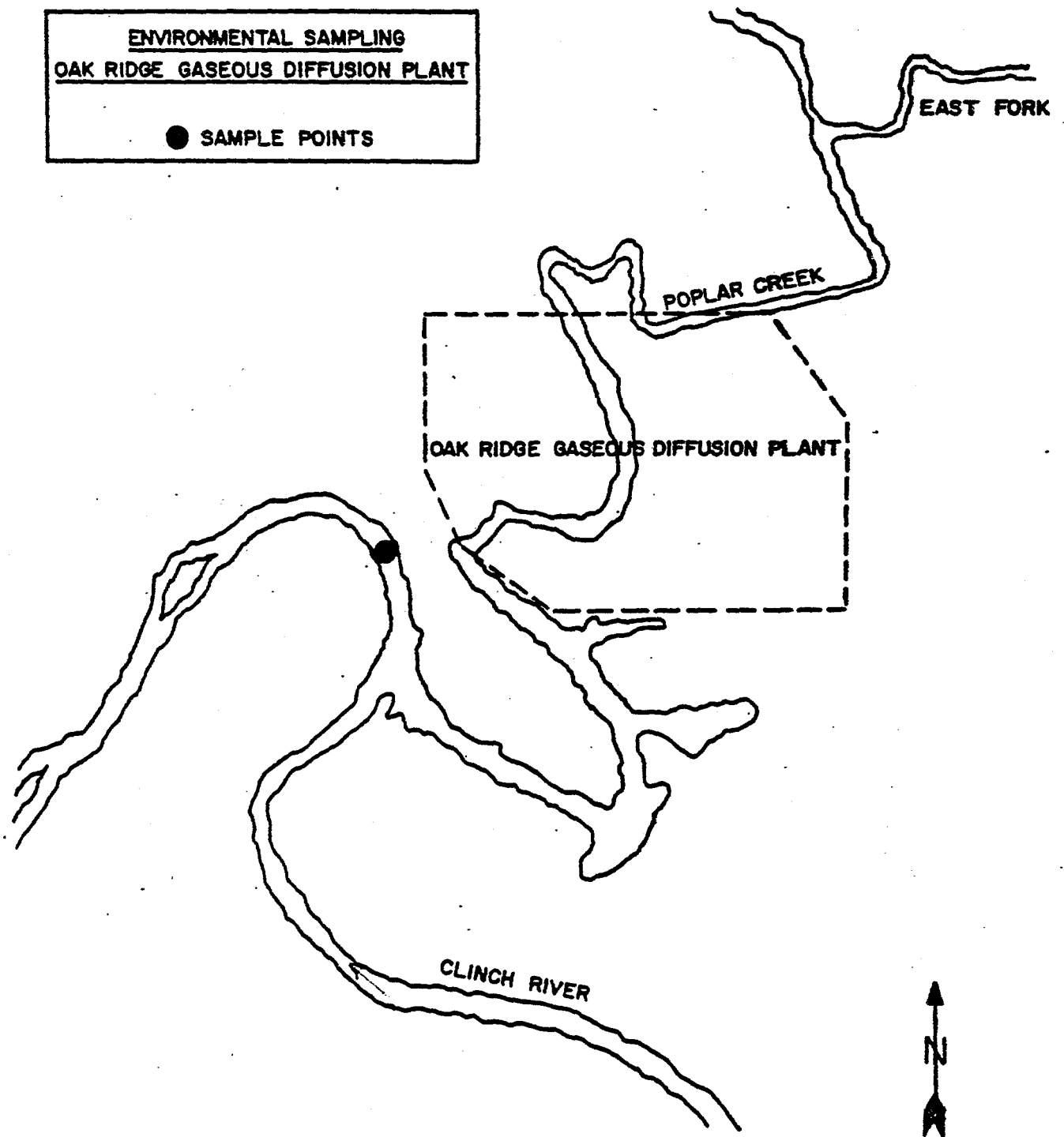


Figure 4

## Discussion of Data

Data on the environmental levels of radioactivity for the last half of 1966 in the Oak Ridge and surrounding areas are presented in Table I through Table IX.

The average air contamination levels for gross beta activity, as shown by the continuous air monitoring filter data, for both the immediate and remote environs of the plants were 0.10% of the maximum permissible concentration for populations in the neighborhood of a controlled area (Table I). These levels are approximately the same as those for the first half of 1966 and are no higher than the average of those measured in other areas of the United States and reported by the U. S. Public Health Service Radiation Surveillance Network for this period. An increase in fallout occurred in the East Tennessee area during the first week of November, 1966. The arrival of the fallout material in the Oak Ridge area was consistent with the timing of the announced nuclear detonation by Communist China on October 27, 1966.<sup>2</sup>

The average air contamination levels for gross alpha activity, as shown by the continuous air monitoring filter data, for the immediate and remote environs of the plants were 0.30% and 0.15%, respectively, of the MPC<sub>a</sub> for natural uranium for application to populations in the neighborhood of a controlled area (Table II).

The average concentration of <sup>131</sup>I in air in the immediate environs of the plants was  $0.012 \times 10^{-12}$   $\mu\text{c/cc}$  (Table III). This is approximately 0.012% of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average concentrations of <sup>131</sup>I in raw milk in the immediate and remote environs of the Oak Ridge area were 8.0 pc/l and 5.9 pc/l, respectively (Table IV). The maximum concentration observed, 114 pc/l, occurred on November 9, 1966, approximately four days after the arrival in the Oak Ridge area of fallout containing fresh fission products. The average values fall within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day.

The average concentration of <sup>90</sup>Sr in raw milk for the immediate and remote environs of the controlled area were 27 pc/l and 24 pc/l respectively. These levels fall near the lower limit of FRC Range II for transient rates of daily intake of <sup>90</sup>Sr for application to the average of suitable samples of an exposed population.

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and the measured average concentration at Mile 4.5, near Kingston, Tennessee, were  $1.4 \times 10^{-8}$   $\mu\text{c/ml}$  and  $0.68 \times 10^{-8}$   $\mu\text{c/ml}$ , respectively. These values are 0.63% and 0.45% of the weighted average maximum permissible concentrations (MPC)<sub>w</sub>.

---

<sup>2</sup>Radiological Health Data and Reports, U. S. Department of Health, Education and Welfare, Vol. 7, No. 11, November 1966.



The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was  $0.99 \times 10^{-10}$   $\mu\text{c}/\text{ml}$  which is approximately 0.005% of the weighted average  $(\text{MPC})_w$  value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge plants, was  $< 0.01\%$  of the  $(\text{MPC})_w$  for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge area was 0.012 mR/hr, which is approximately the same as the level measured in the early period prior to Oak Ridge Operations.

### Conclusion

Surveillance of the radioactivity in the Oak Ridge environs indicated that the major part of the radioactivity detected continues to be the result of fallout from weapons testing. While some low level radioactivity is being released to the environment from plant operations, the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and intake guides for the neighboring population.

TABLE I  
CONTINUOUS AIR MONITORING DATA  
Long-Lived Gross Beta Activity of  
Particulates in Air

July - December, 1966

Station Number	Location	Number of Samples Taken	Units of $10^{-13}$ $\mu\text{c/cc}$			% (MPC) <sub>a</sub> <sup>c</sup>
			Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	26	3.4	0.09	0.89	0.09
HP-32	Midway Gate	26	4.6	0.13	1.1	0.11
HP-33	Gallaher Gate	26	2.5	0.06	0.75	0.08
HP-34	White Oak Dam	26	3.5	0.11	0.77	0.08
HP-35	Blair Gate	26	4.4	0.00	0.89	0.09
HP-36	Turnpike Gate	182 <sup>d</sup>	5.4	0.24	1.4	0.14
HP-37	Hickory Creek Bend	26	3.8	0.11	0.83	0.08
HP-38	East of EGCR	26	4.9	0.00	0.96	0.10
HP-39	Townsite	26	6.6	0.08	1.1	0.11
Average			4.3	0.09	0.97	0.10
<u>Remote Stations</u>						
HP-51	Norris Dam	26	6.0	0.13	1.1	0.11
HP-52	Loudoun Dam	25	5.0	0.10	0.99	0.10
HP-53	Douglas Dam	26	4.9	0.00	1.0	0.10
HP-54	Cherokee Dam	26	5.5	0.20	0.93	0.09
HP-55	Watts Bar Dam	26	6.2	0.08	0.86	0.09
HP-56	Great Falls Dam	26	5.5	0.07	1.2	0.12
HP-57	Dale Hollow Dam	26	5.8	0.04	0.94	0.09
HP-58	Knoxville	24	6.0	0.13	1.1	0.11
Average			5.6	0.09	1.0	0.10

<sup>a</sup> Maximum weekly average concentration.

<sup>b</sup> Minimum weekly average concentration.

<sup>c</sup> (MPC)<sub>a</sub> is taken to be  $10^{-10}$   $\mu\text{c/cc}$  as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>d</sup> Samples collected on daily schedule beginning 5/7/62. Maximum and minimum daily average concentrations were  $20 \times 10^{-13}$   $\mu\text{c/cc}$  and  $< 0.01 \times 10^{-13}$   $\mu\text{c/cc}$ , respectively.

TABLE II  
CONTINUOUS AIR MONITORING DATA  
Long-Lived Gross Alpha Activity of  
Particulates in Air

July - December, 1966

Station Number	Location	Number of Samples Taken	Units of $10^{-13}$ $\mu\text{c/cc}$			$\%$ (MPC) <sub>a</sub> <sup>c</sup>
			Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
<u>Perimeter Stations</u>						
HP-31	Kerr Hollow Gate	26	0.09	<0.01	0.05	0.25
HP-32	Midway Gate	26	0.12	<0.01	0.07	0.35
HP-33	Gallaher Gate	26	0.14	<0.01	0.05	0.25
HP-34	White Oak Dam	26	0.11	<0.01	0.04	0.20
HP-35	Blair Gate	26	0.57	<0.01	0.08	0.40
HP-36	Turnpike Gate	182 <sup>d</sup>	0.24	<0.01	0.13	0.65
HP-37	Hickory Creek Bend	26	0.08	<0.01	0.04	0.20
HP-38	East of EGCR	26	0.12	<0.01	0.03	0.15
HP-39	Townsite	26	0.14	<0.01	0.06	0.30
Average			0.18	<0.01	0.06	0.30
<u>Remote Stations</u>						
HP-51	Norris Dam	26	0.07	0.01	0.04	0.20
HP-52	Loudoun Dam	25	0.07	<0.01	0.04	0.20
HP-53	Douglas Dam	26	0.07	0.01	0.03	0.15
HP-54	Cherokee Dam	26	0.06	<0.01	0.03	0.15
HP-55	Watts Bar Dam	26	0.06	<0.01	0.03	0.15
HP-56	Great Falls Dam	26	0.05	0.01	0.03	0.15
HP-57	Dale Hollow Dam	26	0.07	<0.01	0.03	0.15
HP-58	Knoxville	24	0.07	<0.01	0.04	0.20
Average			0.06	<0.01	0.03	0.15

<sup>a</sup>Maximum weekly average concentration.

<sup>b</sup>Minimum weekly average concentration.

<sup>c</sup>(MPC)<sub>a</sub> used is  $20 \times 10^{-13}$   $\mu\text{c/cc}$ , the MPC for natural uranium as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>d</sup>Samples collected on daily schedule beginning 5/7/62.

TABLE III  
 CONCENTRATION OF  $^{131}\text{I}$  IN AIR  
 AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS

July - December, 1966

Number of Samples	Units of $10^{-12}$ $\mu\text{c/cc}$			% (MPC) <sub>a</sub> <sup>b</sup>
	Maximum	Minimum <sup>a</sup>	Average	
206	0.12	< 0.010	0.012	0.012

<sup>a</sup>Minimum detectable amount of  $^{131}\text{I}$  is 20 d/m. At the average sampling rate used, this corresponds to approximately  $0.010 \times 10^{-12}$   $\mu\text{c/cc}$ . In averaging, one-half of this value, 10 d/m, is used for all samples showing a total amount of  $^{131}\text{I}$  less than 20 d/m.

<sup>b</sup>(MPC)<sub>a</sub> is taken to be  $1 \times 10^{-10}$   $\mu\text{c/cc}$  as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE IV  
CONCENTRATION OF  $^{131}\text{I}$  IN RAW MILK

July - December, 1966

Location	pc/l		
	Maximum	Minimum <sup>a</sup>	Average
Immediate Environs	114	< 10	8.0
Remote Environs	15	< 10	5.9

<sup>a</sup> Minimum detectable concentration of  $^{131}\text{I}$  is 10 pc/l. In averaging, one-half of this value, 5 pc/l, was used for all samples showing a concentration less than 10 pc/l.

TABLE V  
CONCENTRATION OF  $^{90}\text{Sr}$  IN RAW MILK

July - December, 1966

Location	pc/l		
	Maximum	Minimum <sup>a</sup>	Average
Immediate Environs	53	6.8	27
Remote Environs	40	14	24

<sup>a</sup> Minimum detectable concentration of  $^{90}\text{Sr}$  in milk is 2 pc/l. In averaging, one-half of this value, 1 pc/l, was used for all samples showing a concentration less than 2 pc/l.

TABLE VI

CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY  
IN THE CLINCH RIVER AT MILE 20.8

July - December, 1966

Number of Samples Taken	Units of $10^{-7}$ $\mu\text{c/ml}$			% of (MPC) <sub>w</sub>
	Maximum <sup>a</sup>	Minimum <sup>b</sup>	Average	
182	0.78	0.01	0.14	0.63

<sup>a</sup>Maximum weekly average.

<sup>b</sup>Minimum weekly average.

TABLE VII  
AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS  
IN THE CLINCH RIVER

July - December, 1966

Location	Units of $10^{-8}$ $\mu\text{C}/\text{ml}$							% of (MPC) <sub>w</sub>	
	<sup>90</sup> Sr	<sup>144</sup> Ce	<sup>137</sup> Cs	<sup>106</sup> Ru	<sup>60</sup> Co	<sup>95</sup> Zr - <sup>95</sup> Nb	Average Beta Activity	(MPC) <sub>w</sub> <sup>a</sup>	(MPC) <sub>w</sub>
Mi. 23.1 <sup>b</sup>	0.05	0.02	*	0.01	*	*	0.08	50	0.16
Mi. 20.8 <sup>c</sup>	0.06	<0.01	0.02	0.43	0.05	0.01	1.4	220	0.63
Mi. 4.5	0.13	0.03	0.19	0.20	0.13	*	0.68	150	0.45

<sup>a</sup>Weighted average (MPC)<sub>w</sub>, calculated for the mixture using (MPC)<sub>w</sub> values for specific radionuclides specified by AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

<sup>b</sup>Sampling station moved from Clinch River Mile 41.5 to Melton Hill Dam, CRM 23.1 about January 1, 1966.

<sup>c</sup>Values given for this location are calculated values based on levels of waste released and the dilution afforded by the river; they do not include amounts of radioactive material (e.g., fallout) that may enter the river upstream from CRM 20.8.

\* None detected.



TABLE VIII  
URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1966

Sampling Point	Type of Analyses Made	No. of Samples <sup>a</sup>	Units of $10^{-8}$ $\mu\text{c/ml}$			% (MPC) <sub>w</sub>
			Maximum <sup>b</sup>	Minimum <sup>b</sup>	Average <sup>b</sup>	
Downstream from ORGDP	Uranium Concentration	2	< 0.1	< 0.1	< 0.1	2000 < 0.01

<sup>a</sup> Normal Sampling Frequency: Continuous, composited over one quarter.

<sup>b</sup> No uranium was detected in Clinch River water samples during this period. Minimum detectable concentration of uranium in river water is  $0.1 \times 10^{-8}$   $\mu\text{c}$ .

TABLE IX

## EXTERNAL GAMMA RADIATION LEVELS

mR/hr

July - December, 1966

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Solway Gate	0.012	0.012	0.011	0.012	*	*	0.012
2	Y-12, East Portal	0.011	0.012	0.011	0.010	*	*	0.011
3	Newcomb Road, Oak Ridge	0.010	0.012	0.012	0.013	*	*	0.012
4	Gallagher Gate	0.010	0.010	0.010	0.012	*	*	0.011
5	White Wing Gate	0.012	0.011	0.012	0.011	*	*	0.012
Average		0.011	0.012	0.011	0.012			0.012

Note: These readings were taken with a calibrated Geiger-Müller tube at a distance of three feet above the ground.

The background in the Oak Ridge area in 1963 was determined to be approximately 0.012 mR/hr.

\*No measurement made.

ChemRisk Document Request Transmittal Form  
(This section to be completed by ChemRisk)

Name S. Sandberg Division 1 ISD is requested to provide the following document

Address \_\_\_\_\_

Date of Request 12/10 Expected receipt of document 12/21

Title of requested document Env Levels of Radioactivity

Document Number ~~800824~~<sup>25</sup> ~~800831~~ 800827

Access Number of Document \_\_\_\_\_ Date of Document 1962-1965

(This section to be completed by Derivative Classifier)

Derivative Classifier T.G. Jordan Phone 4 1645

Date document transmitted to Dr. Quist 4/15/93 1/29/93

Date release received from Dr. Quist O.K. Q82 1/29/93

PUBLIC RELEASE STAMP attached to each copy of document ( YES NO )

Date document sent to reproduction \_\_\_\_\_ Expected Return \_\_\_\_\_

Delivered to DRC by \_\_\_\_\_ Date \_\_\_\_\_

(This section to be completed by DRC)

Received by DRC \_\_\_\_\_ Date \_\_\_\_\_

Processed \_\_\_\_\_

Mailed \_\_\_\_\_

1993 FEB - 3 PM 5:49

# OAK RIDGE K-25 SITE DOCUMENT RELEASE FORM

Person requesting release JENNIFER LAMB (CHEMRISK)

Mailing Address K-1200 MS-7262

Date by which release is required \_\_\_\_\_

Some documents require special \_\_\_\_\_

Rec'd K-25CO: 1/29/93  
 c: JLamb  
 File-K25CO-RC(4710) No.  
 AS Quist, 2/1/93

4-0745

processing time is 5 working days.

(will be longer).

Note: Two copies of the document must generally be provided to the \_\_\_\_\_  
 one copy of photos and videotapes is required. Documents that it \_\_\_\_\_

Information Control Office with this request. Only  
 must be accompanied by "originals" of the photos.

Approval of request for Classification and Information Control Office to release document (department head or higher):

Signature: \_\_\_\_\_

Date \_\_\_\_\_

## DOCUMENT DESCRIPTION (to be completed by requester)

Document number UNNUMBERED/800827

Pages 19

Document title ENVIRONMENTAL LEVELS OF RADIOACTIVITY FOR THE OAK RIDGE AREA (REPORT FOR PERIOD JULY - DECEMBER, 1966)

Author(s) (indicate other divisions or organizations, if applicable) \_\_\_\_\_

**HEALTH PHYSICS AND SAFETY SECTION**

Document type (See Doc. Prep. Guide, Chs. 1 and 2, for definitions of document types):

- |                                                                                               |                                                     |                                                  |                                   |                                        |
|-----------------------------------------------------------------------------------------------|-----------------------------------------------------|--------------------------------------------------|-----------------------------------|----------------------------------------|
| <input type="checkbox"/> Formal Report                                                        | <input checked="" type="checkbox"/> Progress Report | <input type="checkbox"/> Informal R&D Report     | <input type="checkbox"/> Abstract | <input type="checkbox"/> Drawing       |
| <input type="checkbox"/> Administrative                                                       | <input type="checkbox"/> Correspondence             | <input type="checkbox"/> Internal Technical Data | <input type="checkbox"/> Photo    | <input type="checkbox"/> Other Visuals |
| <input type="checkbox"/> Journal Article (identify journal): _____                            |                                                     |                                                  |                                   |                                        |
| <input type="checkbox"/> Oral Presentation (identify meeting, sponsor, location, date): _____ |                                                     |                                                  |                                   |                                        |

Will oral presentation be published in program, booklet, brochure, etc.? ☐ Yes ☐ No ☐ Not Known

Will copies of the oral presentation be distributed ☐ before, ☐ after, ☐ during the meeting? ☐ No distribution will be made.

☐ Other (specify): \_\_\_\_\_

Purpose of release HEALTH STUDY FEASIBILITY PROJECT

Previously cleared documents containing similar information \_\_\_\_\_

Is copyrighted material contained in this document? (If present, attach release.) ☐ Yes ☒ No

Remarks \_\_\_\_\_

## CLASSIFICATION INFORMATION (to be obtained by requester)

Was the work reported in this document funded, in whole or in part, by a classified program at Martin Marietta Energy Systems, Inc.?

☐ No ☐ Yes (Name of program: \_\_\_\_\_ )

Is the subject area of this document closely related to a prior or current classified program at Martin Marietta Energy Systems, Inc.?

☐ No ☐ Yes Within the Department of Energy? ☐ No ☐ Yes

Name or Description of applicable program(s) \_\_\_\_\_

Additional remarks \_\_\_\_\_

This document contains no classified information.

Derivative Classifier signature \_\_\_\_\_

Date 1/14/93

**DISTRIBUTION LIMITATIONS (If any) (completed by requester)**

☐ Unrestricted, unlimited

Distribution may be limited because this document contains information that is:

☐ Unclassified Controlled Nuclear Information \*

☐ Applied Technology \*

☐ Export Controlled \*

☐ Naval Nuclear Propulsion Information \*

☐ Gov't Confidential Commercial Information \*

☐ Proprietary

☐ Sensitive Nuclear Technology \*

☐ Small Business Innovation Research \*

☐ Official Use Only

☐ Safeguards Information \*

☐ Cooperative R&D Agreement \*

☐ Other

\* Generally identified by sponsor

Remarks: \_\_\_\_\_

**PATENT INFORMATION (completed by requester)**

Does this document disclose any new equipment, process, or material?

☐ Yes

☐ No

If yes, list the patent significance and identify page number(s) and line number(s) in the space immediately following (or attach separate pages).

**PATENT SECTION ACTION (completed by Patent Section upon request by the Classification and Information Control Office)**

☐ Document may be released for publication

☐ Document must be reviewed by DOE Patent Group before release

☐ Document contains patentable information and may not be released at this time

Remarks: \_\_\_\_\_

Patent Section Representative \_\_\_\_\_

Date \_\_\_\_\_

**CLASSIFICATION AND INFORMATION CONTROL OFFICE ACTION (completed by Classification and Information Control Office)**

Classification Office  
Action Taken:

☐ Not approved for release (see below)

☐ Approved for release with changes (see below)

☐ Approved for release without change

Classification Officer signature \_\_\_\_\_

Date \_\_\_\_\_

Technical Information  
Office Action Taken:

☐ Not approved for release (see below)

☐ Approved for release with changes (see below)

☒ Approved for release without change

Technical Information Officer Signature *Arvin A. Jank*

Date *1/29/93*

Send to OSTI?

☐ Yes

☐ No

Category Distribution: \_\_\_\_\_